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LOCAL RAW MATERIALS IN THE PRODUCTION OF GLASS, BRICKS AND TILES IN U.A.R.

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LOCAL RAW MATERIALS IN THE PRODUCTION OF GLASS, BRICKS AND TILES IN U.A.R.

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PART I. GLASS

INTRODUCTION:

1. The modern glass industry started in Egypt in 1932 when a small facotry started melting glass from its raw materials and such articles as lamp chimneys, tableware and medicine bottles were manufactured manually.

2. In 1952, the glass industry in Egypt was partly automized and nowadays bottles, tableware and sheet glass are produced by almost fully automatic production units. The yearly production of glass in Egypt is about 50,000 tons and is expected to increase to 100,000 tons/year in 1970. The new projects include the production ground and polished plate glass, coloured glass for bottles and jars, borosilicate glass and lead oxide containing glass for optical and decorative (crystal) purposes.

The progressive increase in the production of glass and the necessity for improvement of the quality since 1952 was met through the progress in applied and development research which was carried out, mainly in the glass-research unit of the National Research Centre and partly in the glass factories. These investigations included studies on the possible use of local raw materials, improvement of the melting techniques and the choice of the most suitable batches for the different varieties of glass produced.

RAW MATERIALS

Sand:

4. Before 1955, all sands used for glass making were imported from France, Belgium and Holland. In the study of the possible use of local sands, it was necessary to divide the sands into three types, namely -

(a) Sands suitable for the manufacture of white colourless glass for tableware and bottles: The sand deposits in Syna desert at about 150 kilometres from Suez were found suitable for this purpose. The chemical analysis of a number of samples taken from different parts of these deposits showed that:

SiO_2	content ranges from	98	to 99%
Fe_2O_3	" " "	0.03	to 0.05%
Al_2O_3	content is about	1.0%	
CaO	" " "	0.4%	

The particle size is mostly between 0.1 mm and 1 mm in diameter. Occasionally some parts of the sand deposit showed more fines (less than 0.1 mm in diameter) than would be required. This was usually associated with a high iron oxide content (about 0.05% Fe_2O_3). Washing with water in specially designed continuous washers eliminated the greatest part of the fine particles and reduced the Fe_2O_3 content to 0.03%.

The manufacture of all the white colourless glass for bottles and tableware is now made from this sand of which about 10,000 tons are used per year. This figure is expected to be doubled in 1970. The deposits of sand in Syna contain over one million tons.

(b) Sands suitable for making sheet, plate and rolled plate glass: The sand deposit in Maadi Desert, about 20 kilometres from the centre of Cairo, was investigated. The raw sand is inhomogenious containing a considerable proportion of aluminous clay (6 to 8%). The particles vary in diameter between 0.05 mm and 3 mm., and are irregular in shape. The silica content varies from 94 to 96% and the iron content (as Fe_2O_3) varies from 0.3 to 0:64. It was found, however, that by careful selection of the white sand varieties and partial sieving to remove the coarse particles at the sand deposit in the desert followed by washing with water and sieving, sands of a more or less consistent chemical and physical compositions could be obtained. The resulting sand contained about 96.5% SiO_2, 0.15% Fe_2O_3 and 2.0% Al_2O_3 and the particles had diameters between 0.1 and 0.6 mm.

In 1961, about 13,000 tons of this processed sand were prepared at a cost of about 30% the cost of imported sands and were used in the manufacture of 18,000 tons of sheet and rolled-plate cathedral glass. It is expected that 30,000 tons of this sand will be used in 1970 for the manufacture of about 40,000 tons of sheet, plate and rolled plate glass.

(c) Sands suitable for making coloured glass. Samples from the sand in the deserts around Cairo, between Cairo and Alexandria and between Cairo and Suez have been investigated. They all showed a high iron content, from 0.5 to 1% Fe_2O_3, and a silica content of 94 to 97%. The particle size is also variable ranging from 0.01 to 3 mm in diameter but in all cases it was found possible to sieve

the sand manually or automatically giving the particles of the required size (from 0.2 to 0.6 mm diameter).

Experimental meltings showed that these sands are suitable for manufacturing green and brown glass for such articles as beer bottles and margarine jars.

For the manufacture of the fine quality of coloured tableware glass of the blue, red, yellow and similar colours, a sand of a lower iron content than these sands will be required. The washed and sieved Maadi sand is suitable for this purpose.

As a result of these findings, El Nasr Glass Company in Cairo is planning the production of about 12,000 tons/year of green and brown glass for bottles and jars. A site as near as possible to the sand deposit is now under-choice where a new factory is expected to start this production in 1964. It is expected that by 1970 the production will be double this quantity. The same Company is also planning the production of about 1000 tons of coloured tableware glass in small day tanks which is expected to start in 1964.

Sources of alkalis:

(a) The greatest part of the alkalis used in the glass manufacture is Na_2O which is mainly introduced in the form of imported sodium carbonate. The introduction of up to 20% of the Na_2O required for glass in the form of sodium sulphate, which is obtained as a by-product in the rayon industry is a possibility.

(b) Local felspars containing up to 10% (Na_2O + K_2O) are also possible sources of alkalis as well as alumina.

(c) Natron, from the well-known Natron Valley, has been the subject of an extensive investigation from which it was realized that some of the lakes are rich in their Na_2CO_3 content although most of the lakes contain mixtures of Na_2CO_3, Na_2SO_4 and NaCl. The presence of a high proportion of NaCl in these mixtures limits their use in the glass industry but experimental meltings proved that it is possible to introduce up to 40% of the alkalis in coloured green and brown glass in the form of natron while only 20% of the alkalis in sheet glass can be introduced in the form of the Na_2CO_3 - rich natron deposits.

6. Sources of lime and magnesia:

(a) The calcium carbonate in Upper Egypt, at about 200 kilometres south Cairo, is of the pure chalk quality containing about 99.5% $CaCO_3$ and not more than 0.01% Fe_2O_3 which makes it an excellent source of CaO in the manufacture of the best quality white colourless glass.

(b) The limestones of Tourah (20 kilometres from the centre of Cairo) and Helwan (40 kilometres from the centre of Cairo) contain about 98.C% $CaCO_3$ and 0.05 to 0.1% Fe_2O_3 and they can be used in the manufacture of sheet, plate, rolled-plate and coloured glass.

(c) Iron slags from the blast-furnaces can be used as sources of CaO and Fe_2O_3 in the manufacture of green and brown bottles.

(d) The magnesia is mostly introduced in the form of dolomite from Attaka near Suez which contains about 29% CaO, 18% MgO and 0.1% Fe_2O_3. The high iron content limits its use to the sheet, plate, rolled-plate and coloured glass.

(e) The recent discovery of magnesite near El Kouseir which contains about 97% $MgCO_3$ and 0.04% Fe_2O_3 is expected to enable the replacement of the present imported low-iron dolomite for the production of white colourless glass.

Batches:

7. The development of new batches to suit our local raw materials and to suit our requirements of better glass quality may be quoted as examples.

In the production of sheet glass (Fourcault process) the following ranges of glass composition can be used:

SiO_2	from	71	to	72.5%
Al_2O_3	"	0.5	to	1.5%
CaO	"	6.5	to	7.5%
MgO	"	2.8	to	3.1%
Na_2O	"	14.5	to	15.5%
SO_3	about	0.5%		

8. The rolled plate glass can be made from the following glass composition:

SiO_2	from	72.0	to	74%
Al_2O_3	"	1.0	to	2.0%
CaO	"	7.5	to	8.5%
MgO	"	1.5	to	2.0%
Na_2O	"	14	to	15%
SO_3	about	0.5%		

9. When the total requirements of both sheet and rolled plate glass do not justify the production of these two types of glass each in one separate furnace, it is recommended that a glass of the following composition would suit the two types of glass:

SiO_2	72.5%
Al_2O_3	1.5%
CaO	7.2%
MgO	2.8%
Na_2O	15.5%
SO_3	0.5%
	100.0%

10. Part of the horizontally drawn glass can be drawn plain followed by grinding and polishing thus giving plate glass.

11. In the manufacture of white colourless tableware and bottles, our experience indicates the possible use of one glass composition, namely,

SiO_2	72.5%
Al_2O_3	1.5%
CaO	8.5%
MgO	2.0%
Na_2O	15.5%
	100.0%

PART II. BRICKS AND TILES

Introduction:

12. In Egypt, the brick making is one of the oldest arts known. The oldest bricks found are of pre-dynastic date of Sakkara and Abydos in the tombs of the first and second dynasty.

13. The brick manufacture in Egypt up till now, is depending on the Nile silt, which is a mixture of clay (Illite mineral) and sand, containing variable amounts of impurities. The constitution of the Nile silt varies greatly from year to year and from place to place, and such non homogenity accounts for the difficulties in producing a good building brick.

14. For acquiring the necessary raw material for brick making silting basins are chosen near the brick factories, at the banks of the Nile. The Nile flood-water, tarbid with silt, is allowed to flow in and out the basin precipitating the silt en route. The rate and type of silt deposition depends on the shape, grain size, specific gravity of the constituting materials as well as velocity of the current and the design of the silting basins. It is therefore evident that the silting basin contains a varied mixture of sandy silt, silt and mud. Due to these conditions the brick industry became a matter of individual practice and no technological help could be given. This accounts for the poor quality building bricks produced.

15. After the construction of the High Dam at Asswan, the major part of the silt will be deposited behind the dam and its amount would be naturally less. Also its grain size and concentration, coming to Egypt, would be small and accordingly the quantity of silt deposition in the brick factories basins would be hardly enough to suffice the eight million tons of silt they need every year.

16. New natural raw materials of clay and sand to replace the Nile silt would be the welcomed answer to such a national problem facing the brick industry in the UAR. The present requirements of eight million tons of clay per year would naturally be doubled to meet the new building development schemes in the UAR five year plan.

Clay deposits:

17. Huge deposits of natural clays are found and geologically sampled from different localities of the UAR, Syria and Lybia. In UAR workable clay beds are found in the Mokkattam Hills boardering Cairo, at Tebbyne 40 kilometres from Cairo, at Abou // Menya in Upper Egypt. In other Arab Countries: Syrian, clays are found at Zabadanis and the Libyan clays at the Gerian locality.

18. The workability of these clays are found to be good and suitable for ordinary hand moulding as well as mechanical forming. Mineralogically speaking they belong/the clay mineral /to group Illite, the same type of mineral the Nile silt contains. Beside the mineral Illite they contain varying amounts of free silica or quartz sand, mainly required in mixes of brick production.

19. The chemical constitution reveals that these clays contain appreciable amounts of iron oxide which is responsible for the different pattern of yellow, orange and red colour the bricks show when fired. They contain fair amounts of fluxes which would help their vitrification at a reasonable low firing temperature and therefore would cut their firing production costs.

Brick and tile making:

20. In the light of physical characteristics of the clays, their mineral and chemical constitution and their thermochemical behaviour when heated - sample briquettes were formed. Perforated bricks and tiles were processed by varying means of mechanical brick making machines. Samples were formed using the ordinary extrusion method without passing the mix between the rollers. Another set of samples were prepared by passing the mix between the double rollers before extruding. A third set of samples were prepared using the extrusion method combined with the dearing mechanism but without passing the mix through the rollers. The fourth set of samples were prepared by passing the mix through the double rollers and using the extrusion method combined with the dearing mechanism, This was applied on different mixes of clay and sand, the latter being added to the clay in amounts ranging between 10 to 50% by weight.

21. The different series of samples formed were subjected to varying conditions of natural and artificial drying and their drying behaviour followed. The dried samples are then fired at 700, 800, 900 and 1000 degree centigrade under different rates of firing. This enabled us to determine the suitable mixes and the proper conditions of drying and firing such mixes. The selected successful batches and their fired products are tested to examine their physical and mechanical properties, as shown in Table I and Table II.

22. It is evident from these results that the extension method of forming combined with dearing would produce a stronger dense type of perforated building unit. It is, however, interesting to note the wide variation in strength when the samples of the perforated bricks are tested in the crushing strength test at

// Rawash near Cairo, at the Kharga Oasis in the western desert, and at

position 1, 2 and 3 as shown in Fig. I. Position 1 showed the highest strength followed by position 2, followed by position 3 which showed the lowest strength as shown in Table II. This is mainly due to the effective bearing are a (gross area) in the three positions the load was applied on. Such results may indicate the possibility of using such units in bearing well construction.

Low cost houses:

23. The cost of the perforated building units have been calculated from actually producing industrially half a million of these units. The cost of one thousand units size 25x12x13 cms was found to be seven Egyptian Pounds which is about the same cost of similar volume of the ordinary common red brick produced in UAR.

24. Accordingly extensive studies have been made to put the technological and economical project for small mechanical building plants to be established in different parts of the UAR. Each plant would produce 10 millions perforated units size 25 x 12 x 13 cms, for walls 2 millions perforated units size 50 x 25 x 10 cms for roofs. The cost of the complete factory would amount to about 150,000 Egyptian pounds. The factories are to be erected near the sites where the clay and sand occur. The UAR would need to erect about 100 of these factories in order to meet the increasing demand of building bricks needed for the huge building schemes in the coming five years. Some of these factories are about to be erected in Kharga Oasis where building construction are being hindered by the high cost of transportation.

25. The flexibility of the extrusion type of machines in these factories would enable the production of various shapes of perforated units for walls, roofs and floors cutting the cost of present construction by 25%.

26. A new design for a low cost farmer's house Fig. 2, has been claimed. The use of the perforated units in such houses would lower considerably the final cost. Fixed furniture in the design are shown.

TABLE I

Composition		Firing Temperature 700°C.					
		Extrusion Only			Extrusion qnd Deqiring		
Clay	Sand	Bulk Density	Porosity	Water Absorption	Bulk Density	Porosity	Water Absorption
100	0	1.24	25.33	13.10	1.28	24.54	12.30
90	10	1.25	25.46	13.12	1.28	24.65	12.44
80	20	1.27	25.60	13.22	1.32	24.88	12.56
70	30	1.29	25.80	13.30	1.32	24.91	12.60
60	40	1.29	27.65	14.61	1.32	27.00	14.10
50	50	1.26	29.50	15.77	1.29	29.31	15.45

Composition		Firing Temperature 800°C.					
		Extrusion Only			Extrusion and Deairing		
Clay	Sand	Bulk Density	Porosity	Water Absorption	Bulk Density	Porosity	Water Absorption
100	0	1.22	25.00	12.45	1.26	23.70	11.97
90	10	1.23	25.00	12.50	1.28	24.65	12.15
80	20	1.25	25.54	13.19	1.28	24.44	12.53
70	30	1.27	25.60	13.25	1.28	24.50	12.60
60	40	1.29	27.42	14.40	1.32	26.70	13.90
50	50	1.252	29.20	15.50	1.26	29.00	15.25

TABLE II

Composition		Crushing Strength in Kg./cm.^{2} at Position 1			
		Extrusion Only		Extrusion and Deairing	
Clay	Sand	Fired at 700°C	Fired at 800°C	Fired at 700°C	Fired at 800°C
100	0	207	310	253	322
90	10	160	230	170	279
80	20	146	153	159	170
70	30	105	141	144	160
60	40	84	102	105	142
50	50	60	69	75	80

Composition		Crushing Strength in Kg./cm.^{2} at Position 1			
		Rollers and Extrusion		Rollers, Extrusion and Deairing	
Clay	Sand	Fired at 700°C	Fired at 800°C	Fired at 700°C	Fired at 800°C
100	0	223	300	230	340
90	10	168	187	191	240
80	20	150	160	168	172
70	30	112	140	145	160
60	40	91	92	94	140
50	50	60	64	66	72

TABLE III

Composition		Firing Temperature 900°C - C.S in Kg./cm^2.					
		Extrusion Only			Extrusion and Deairing		
Clay	Sand	Position 1	Position 2	Position 3	Position 1	Position 2	Position 3
100	0	370	150	73	640	193	80
90	10	294	91	40	397	106	51
80	20	270	81	32	274	101	46
70	30	183	76	30	189	85	41
60	40	121	66	25	166	70	33
50	50	86	49	23	80	50	27
Composition		Firing Temperature 1000°C. - C.S in Kg./cm^2.					
		Extrusion Only			Extrusion and Deairing		
Clay	Sand	Position 1	Position 2	Position 3	Position 1	Position 2	Position 3
100	0	557	156	100	721	256	105
90	10	463	126	59	457	145	67
80	20	290	95	44	302	122	50
70	30	193	90	41	256	102	45
60	40	154	71	26	192	80	36
50	50	91	52	24	100	55	32

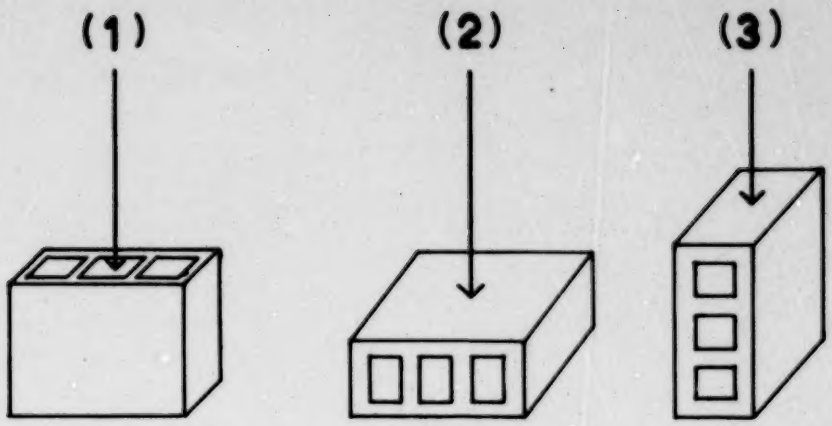
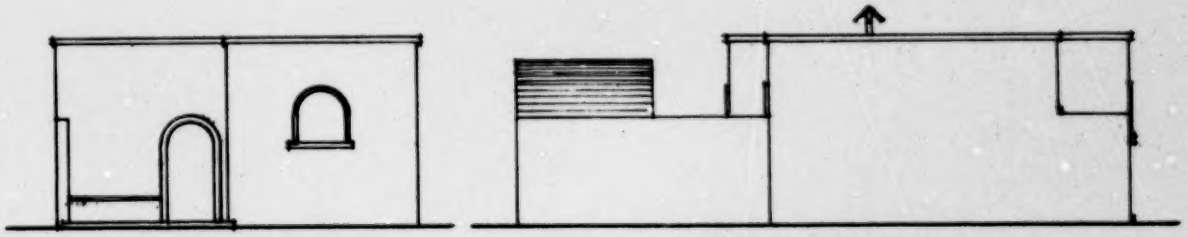
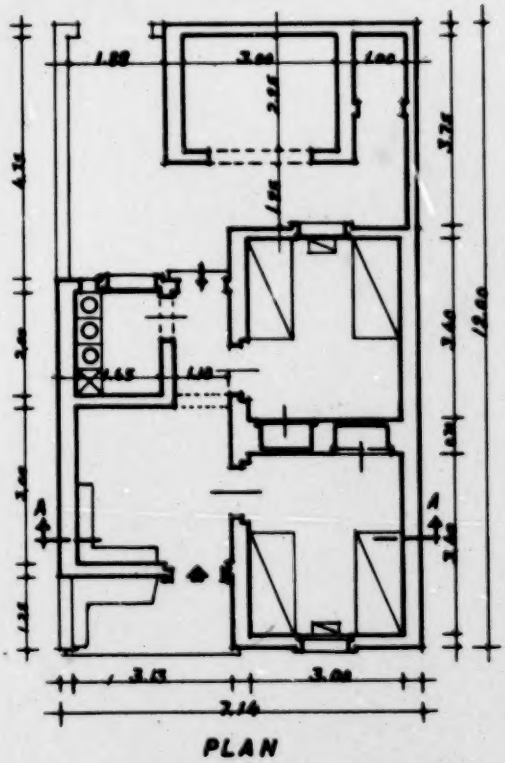


FIG. I

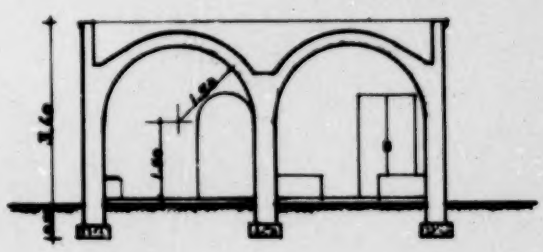


FRONT ELEVATION

SIDE ELEVATION



PLAN



SEC. A - A

LOW COST FARMER'S HOUSE

FIG. II

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